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TRAFFIC CONDITIONS IN VANCOUVER AND THEIR RELATION TO STREET CAR TRAFFIC.

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The street railway system of Vancouver had its inception as a horse car line with about 2½ miles of track in 1891. The following year it was electrified, the original horse cars being converted into trolley cars, with the old T. H. stem-winder equipments. In August of the same year the interurban line between Vancouver and New Westminster, said to be the first strictly interurban electric railway in Canada, was opened.

The collapse of the boom of 1891 resulted disastrously for both these companies, which were consolidated and reorganized, without success, till, in 1897, the British Columbia Electric Ry. Co., with English capital, took over the salvage of all the railway and lighting companies in Vancouver, New Westminster, and Victoria (except the New Westminster municipally owned lighting system), and infused new life into them. The growth of Vancouver had by this time begun to be marked, and the later development taxed the resources of this company to keep up with the demand, creating a traffic condition probably unparalleled in any Canadian city. In 1891 the city had about 13,000 people, which doubled by 1901, doubled again in the next five years, and again doubling in another five years, this rate continuing till arrested in the latter part of 1913 by the general depression preceding the European war. So rapid was the increase in demands upon the street railway, augmented by requirements of franchises obtained from surrounding municipalities, that estimates for extensions of track and equipment, however liberal, rarely met the requirements. The following figures indicate the development in ten years:—

Dec.31	Population			Trade		
	City	Suburbs	Total	Imports	Exports	Total
1906	52,000	10,000	62,000	$ 7,454,000	$ 7,408,000	$14,862,000
1908	66,500	28,000	85,000	13,638,000	6,735,000	20,373,000
1910	93,700	35,000	130,000	16,837,000	7,769,000	24,606,000
1912	122,100	37,000	160,000	32,429,000	8,149,000	40,578,000
1913	114,220	34,000	148,000	44,362,000	11,077,000	55,439,000
1914	106,110	32,000	138,000	38,282,000	17,059,000	55,341,000
1915	97,995	30,000	130,000	25,705,000	15,172,000	40,877,000

How the affected street railway traffic is shown below:—

June 30	Revenue Passengers	Car Miles	Passgrs. per C.M.	Passenger Equipment			Track Mileage
				Single Truck	Double Truck	Total	
1908	14,205,422	1,996,591	7.17	14	47	61	52.54
1910	25,255,931	3,154,251	8.01	8	110	118	60.15
1911	34,008,025	3,859,161	9.04	5	141	146	74.93
1912	44,866,854	5,863,280	7.65	3	171	174	83.97
1913	49,515,333	6,928,120	7.12	3	203	206	95.26
1914	42,216,632	7,019,710	6.01	3	227	230	100.99
1915	30,031,197	6,590,326	4.55	1	229	230	102.07

Geographical Conditions.—The city proper occupies an area about 7½ miles long east and west, by 3 miles north and south, on the northern side of the peninsula formed by Burrard Inlet and the north arm of the estuary of the Fraser River, this peninsula being 9 miles east and west from the eastern city boundary to Point Grey, by from 5 to 6 miles in width. The city has about 5½ miles of frontage on Burrard Inlet, and 2 miles west of this on English Bay, and is almost split in two longitudinally by a tidal inlet called False Creek, about 3 miles long by ½ a mile wide, leaving an irregular peninsula between this and the harbor, which is less than ½ a mile wide near the centre of the city, and terminates in the headland to the northwest occupied by Stanley Park. The western shores of this area, on both sides of the entrance to False Creek, afford fine bathing beaches, to which travel is heavy in the summer, particularly in the evenings and on Sunday afternoons.

The business district is on this smaller peninsula, and occupies a total area of less than a square mile, with a thickly built residence section about 1 1/3 miles in length between it and the beaches, and, excepting from the east, the only access to this district is by three bridges across False Creek, the Main St. bridge at the eastern end, Granville St. bridge at the other end, and Connaught Bridge, the latter used at present by one car line, in the centre. The main traffic artery connecting these two streets is Hasting St., with a parallel route to the north on Cordova St., and Pender St. on the other side, the latter not being occupied by car tracks. Five car lines enter the district across Granville St. bridge, 6 across Main St. and 4 enter from the east. Thus practically every line crosses either the intersection at Main and Hastings St., where the movement of cars in rush hours exceeds 210 an hour, or that at Hastings and Granville, where over 160 cars an hour pass. Hastings St. has a maximum of 140 cars an hour at the point of lightest traffic between these two points, and the same rate of movement occurs on the first section of Granville St. Parallel lines on Cordova St., north of Hastings, and Richards St. east of Granville, relieve these streets of some traffic. South of False Creek, Broadway is the main east and west artery, connecting Granville and Main Sts. and forming a belt line via Hastings St.

As the formation of the business district is against the use of a central loop with radial lines, the through routing system has been adopted, the main lines entering this section at one end and leaving via one of the other outlets. This route of heaviest traffic serves Grandview in the southeastern part of the city, runs around the head of False Creek, and, passing through Hastings and Granville Sts., serves the southwestern end of the city by a line along Fourth Ave. West. The rush hour service is on a 2½ to 3-minute headway, and from Fourth Ave. a 2-minute headway is maintained between 8.20

and 8.50 a.m. Two lines, one serving the southeast part of the city via Broadway, and the other crossing the suburban area via Main St. to the Fraser River, run opposite ways around the west end loop to English Bay beach, serving that district with 4 and 5 minute schedules. Most of the interchange traffic is thus handled at three transfer points in the business district. The longest line serves South Vancouver via Fraser and Main Sts., crosses the business district via Cordova St., and, turning south again via Granville St., serves the residence section of Shaughnessy Heights, from terminus to terminus being 9.6 miles.

Movement of Traffic.—The morning peak from the south and east, and also the afternoon peak, occur about half an hour earlier than the corresponding peaks on the lines running to the western parts of the city, with the difference that the afternoon rush hour movement eastward is spread over a longer period of time than the latter. On Sundays and holidays, in the summer, travel to the bathing beaches and Stanley Park is heavy in the afternoon and evening, and the evening movement to the theatres and other amusements is augmented during the summer by the heavy travel to the beaches, particularly at English Bay. To handle this traffic, in addition to shuttle cars from Granville St., it has been found necessary to through route some of the cars from the suburbs direct to the Park. In addition to the city service, three interurban lines serve the extreme outlying districts, two to the east and southeast and one to the south and west. Transfers to and from city lines are given on commutation tickets over these lines.

Traffic Studies.—Frequent counts are made of the traffic on the city lines, this being done by placing a man at a suitable observation point, for the whole of a day, or two or three days, as found necessary, who records on a card form the time, car number, route number, direction, and passenger load. From these reports charts are made in the office (a copy of one is appended). Each route is shown in a different color. From these can be easily ascertained the relation of the service given to the demand, the variations in demand at different times, the adherence to schedules obtained, etc. Hourly summaries give the number of cars, seating and "car full" capacity, average load, etc. The service required for each route, or the combined service given by all cars at this point, can be determined. On the basis of this information, together with inspectors' reports, complaints from passengers, etc., the schedules are revised approximately every two months. On completion of the time tables, running sheets are posted in the trainmen's rooms, and crews are allowed to select their runs for the next two months in order of seniority.

Regulation and Inspection.—At all important traffic centres the "pointmen" of the city police force govern the movements of cars along with all other vehicles. The company's inspectors are placed at the principal junction points, or other suitable locations, to maintain headways and control movement of cars, a total of seven men being required. This small force has been able to cover the work, owing to the assistance given by the terminal register clocks used with the coasting recorders. These, instead of being located at terminals, are placed 5 to 7 minutes run therefrom, and cars register en route both ways. This practice eliminates both running ahead of time, and loafing at terminals, and makes the crews try to get over the line in exact time. The clock reports are checked in the office with schedule sheets, and any serious variation from time tables noted, one girl being employed for this work.

The use of coasting recorders, in addition to encouraging more efficient operation of cars, has shown the possibility of higher speeds, and the improvements in service resulting therefrom. While an increase in schedule speeds tends to reduce the percentage of coasting, on the average, there are other advantages which over-balance this, and a mean can be chosen which combines the best service to the public with the most economical running. Higher speeds effect an increase in car mileage, and reduction in headway, without increasing the number of cars and platform expense. The schedule speed possible is, of course, dependent upon the amount of traffic and the loading speeds of the cars.

The following comparison between two months before and after the "jitney" period speaks for itself:—

	December 1913.	April 1916
Number of car routes	22	18
Week day car service—normal	107 cars	108 cars
Week day car service—maximum	182 cars	162 cars
Average daily passengers carried	104,180	71,440
Average daily car mileage	18,860	18,680
Average k.w. hours per car mile	3.94	3.70

The effect on headway and schedule speeds is shown by the following averages of the principal routes; some re-routing has slightly altered the table:—

	Normal service.		Rush hour.	
	1913	1916.	1913	1916.
On five main lines:—				
Number of cars (week days)	57	56	100	99
Average headway, minutes	6	6	4	4
Average schedule speed, m.p.hr.	8.12	9.58	7.81	8.49
On eight through lines:				
Average headway	8.25	8.00	4.70	5.25
Average speed, m.p.hr.	8.53	9.77	8.05	8.93

The higher speeds on the three additional lines in the last comparison are possible owing to their running a larger part of their mileage in suburban territory.

The Jitney.—About the end of Nov., 1914, the now famous "jitney" car appeared in Vancouver. and increased its numbers with amazing rapidity, reaching a total of about 650 machines, although the highest number counted on any one day was on May 8, 1915, when 341 were out. Many of these, however, only operated during busy hours. The effect on the street car traffic was soon noticed, especially in fine weather, but no reduction was made in the service, which was improved by speeding up and readjusting routes. The tendency of the jitney was to attract all traffic to the main business streets, so of course the cars had to follow them. This resulted in complaints from shopkeepers and owners on the deserted streets, where the service was practically limited to the franchise requirements. The most serious result, however, was the increased congestion on the busy streets. The traffic regulations require all vehicles to stop 10 ft. behind a standing car, but when 4 or 5 cars had collected at a corner this could only be applied to the leading one, and the space between cars and sidewalk would become so packed with vehicles that it was almost impossible to reach the cars or get from them to the sidewalks. In an effort to get ahead of each other, the jitneys were crowded on to the tracks between cars, thus lengthening the string. As the jitneys ran on no schedules, they frequently arrived at a corner in flocks, as many as 20 machines being held by one street car,—you can imagine the results.

On May 10, 1915, the company made the experiment of reducing fares, giving 8 non-transfer tickets for 25c., instead of 5 ordinary ones. The result was a 40% increase in the passengers carried, with

no corresponding increase in receipts, but it discouraged the jitneys, and they began to drop out on the longer runs. In June the city made an attempt to regulate them by passing a bylaw requiring license fee, bond of $5,000, and inspection, but no restrictions as to routes or service. About half of them hung on till the end of the summer holiday season, and then they began to drop out, till the cold weather and snow in January of this year almost vanquished them, resulting in a sudden rush of travel on the street cars. When the spring weather set in, however, they returned to business and have now an average of over 100 running daily. At the end of 1915 the low far "tango" ticket was discontinued, as it was found to be insufficient in producing revenue, and a 6 for 25c. ticket with transfer, good at all hours, is now in force. Travel on the cars has held up fairly well, the high price of gasoline preventing the jitneys from adding many to their fleet, but still the amount of traffic is only about two-thirds what it was two years ago. How much of this decrease is due to the jitney and how much to general conditions is difficult to estimate. It is noticeable, however, that if a sudden change to bad weather occurs, there is a decided increase in the loads on the street cars.

In addition to the delays caused by this traffic congestion, which is still serious at times, occasional blockades are encountered at the level railway crossings, of which there are two on the main lines, and two on less important streets. One crossing on Hastings St., two blocks west of Main St., which is used as a transfer between the water front and the local freight and terminal yards, is a particular cause of blockades. Plans are prepared for a tunnel under the higher ground to the west, but this has not yet been realized. Some relief from the traffic congestion in this section has been obtained by the construction of a viaduct from Main St. across the railway yards to Georgia St., near the centre of the west end business section, but this is not yet available for street car traffic.

The establishment of safety zones has been suggested by the city council, but not acted upon as yet. The idea is to have three posts, with chain attached, placed on the street a few feet from and parallel to the car track, during busy hours, to protect people using the cars from passing vehicles.

Government Regulations.—In addition to regulations imposed on other vehicles, the Provincial Government imposes regulations covering the movement and equipment of street cars, also their loading, with an inspector appointed to see to their enforcement. Speed is limited to 8 miles an hour on business streets, and 10 on other streets, subject to the discretion of the Attorney General. Other rules govern speed of cars when passing, warning at crossings, spacing of cars on level and grades, loading of cars, etc.

Equipment.—The Government rules also dealt with the limitation of heights of steps, risers and platforms, the protection of entrances and exits by doors or gates, type of fender, and other safety appliances. Open cars with running board and single truck cars were prohibited, and all cars must be equipped with an efficient power or air brake. On our own initiative we had already discarded single truck and open cars and installed air brakes. The alterations to passenger equipment entailed by these regulations required considerable time and expense, and several schemes were tested before the present standards were adopted. In readjusting step heights, owing to track conditions and other advantages derived from the use of 34 in. steel wheels, we decided to raise instead of lower the car bodies, the

floor level being 44 in. from rail, and use two steps between road and platform, making the bottom one within the prescribed limit of 16 in., with 2 risers of 9⅛ to 10¼ in., and 7⅛ to 9 in. step from platform into car. This extra step with low riser has been found to increase rather than decrease the loading speed, and has been much appreciated by passengers, especially women and children, as on most of our cars a child can mount the steps without assistance.

All single end cars are now fitted with gates at rear entrance and exit, doors being substituted on double end cars. These are in pairs, opening outward, and set on the lower step so that when closed there is no means of hanging on outside. The conductor can operate entrance and exit gates independently or together by the use of a thumb latch which couples the cranks together. At the front exit a door at the platform level, and folding step, are controlled by the motorman. While the speed of loading with the gates has not been accurately timed, there is no doubt that they tend to limit it when any number of passengers are boarding at one point, but this is somewhat offset by the quicker stop and get-away, since the conductor has complete control of his load and there is no hanging to steps or running after the car. The average of boarding and alighting accidents before and after the gates were put on bears a ratio of about 35 to 1. The effect on running time is to reduce the tendency of a crowded car to fall back upon the time of the following car and thus disorganize the headway, as when a car has all it can comfortably carry the entrance gates are kept closed. The cost of maintenance of gates and gear is not excessive, with the present design, a large part of this expense resulting from accidents due to collisions, etc., as the gates and steps are naturally in an exposed position.

Another device which has greatly facilitated car movements is the electric track switch, which is now used at all busy junctions. Some trouble was experienced at first where interurban trains ran over them, the heavy current burning out relays, but this has been eliminated in later designs. No trouble with frost or snow has been experienced, as the use of salt, and a little extra attention, keeps them going.

At attempt was recently made to try the "skip stop" plan on one line where the stops are from 16 to 20 to the mile, but owing to opposition from property owners the city council refused to permit the experiment.

In conclusion, one must admit that the problems to be solved by transportation are not the same in any two street railway systems, and many of our difficulties in Vancouver do not apply with equal force to our Victoria system, but we trust that this somewhat disconnected story of our work may contain something helpful to some other members of the Association.

GEARING AND GEAR RATIOS FOR RAILWAY MOTORS.

By W. G. Gordon, Transportation Engineer, Canadian General Electric Co., Ltd.

The progressive manager of any electric railway today realizes the advance that has been made in recent years in the manufacture and treatment of railway motor gears and pinions, and that the proper selection of the type of gearing and gear ratio has a very direct bearing on his maintenance and power consumption costs. The early types of railway motors had cast iron double reduction gears, and as they were

operated without gear covers the life obtained can readily be imagined. As for noise, one could tell without troubling to look, that a car was approaching while several blocks away. It was a decided step in advance when the double reduction gears were replaced by single reduction gears; cast steel gears superseded the cast iron gears; and more or less successful attempts were made at enclosing the gearing. Constant development has gone on and there now is quite a number of types of gearing to choose from. Although the treatment of the different manufacturers varies, the gears and pinions at present on the market can be classified very closely as follows:—

Cast steel gears and pinions untreated, with an elastic limit of from	25,000 to 30,000 lb.
Forged steel medium carbon gears and pinions untreated, with an elastic limit of from.....	35,000 to 40,000 lb
Forged steel medium carbon oil tempered, with an elastic limit of from	50,000 to 55,000 lb.
Forged steel medium carbon specially heat treated, with an elastic limit of from	140,000 to 150,000 lb.
Forged steel armorized or case hardened, with an elastic limit of from.....	....
Cast steel armorized or case hardened (this type being used for split gears), with an elastic limit of from	....

No figures are given for the elastic limit of the last two types, as in their case this cannot be determined, as the structure of the metal after treatment makes it impossible to obtain a representative test bar.

There is no method except actual use whereby the degree of resistance of steel to wear may be ascertained. As a rough comparison the forged steel, high carbon, oil tempered gears with an elastic limit of from 80,000 to 85,000 lb. can be machined, but under extreme difficulties. The forged steel, medium carbon, specially treated gears with an elastic limit of from 140,000 to 150,000 lb. can just be touched with an ordinary file, and the surface of the armorized or case-hardened gears can only be scratched with the finest Swiss files. Testing devices of the Turner's Sclerometer class, which scratch the surface with a diamond, afford information within certain limits, but the results of such tests are so dependent on the judgment of the operator, that two operators rarely agree upon tests of the same piece of metal. The devices of the Brinnel type, which press a ball of steel or a diamond into the metal, permit the operator to control the duration of pressure and large difference in results from the same piece of metal follow from small differences in the time that pressure is maintained. Moreover, the results have no apparent relation to wearing qualities, but indicate only resistance to deformation. Devices of the Shore's Scleroscope type, where a ball or plunger is bounced upon the metal tested, merely indicate by the extent of the rebound the resilient resistance to compression of both the hammer and the metal. Although this device deprives the operator of control over the duration of impact, the results are materially affected by the thickness of the metal tested and the degree of rigidity of its support. An instrument which will acurately indicate the resistance to abrasion and ordinary wear is yet to be produced.

There are two reasons why the involute or single curve tooth is most commonly used and best suited for railway motor gearing: 1st, because of the thickness at the root of the tooth, and, 2nd, on account

of being able to slightly increase the distance between the centres of the gear and pinion without seriously affecting the mesh of the teeth, this providing for normal wear of the armature and axle linings. For city service we generally use 3 diametral pitch teeth, with occasionally 3½ or 4 diametral pitch on small motors; and for heavier service 2½, 2¼ or 2 diametral pitch. For the smoothest operation the teeth should conform to the standard 14½ degree pressure angle. In some instances, however, the designer has to use the 20 degree pressure angle stub tooth, this being much thicker at the base and from 40 to 50% stronger than the standard tooth. The working contact or mesh of the teeth is not, however, as desirable with the 20 deg. pressure angle as with the standard.

Gear and pinion troubles are frequently traced to injudicious treatment while being mounted or removed, and to lack of sufficient care while in service. The practice as here described is being followed by several large operating companies with successful results. All gears and pinions, when being mounted, should first be tried on the shaft by hand. The pinion should bear evenly all around the shaft, and care should be taken to see that the shaft is not swelled at the sides of the key, which is liable to happen if a too tightly fitting key is driven down on its seat. It is important to have clearance between the top of the key and the pinion. If the pinion rides on the key mounting, stresses are apt to be localized in the body of the pinion, which may lead to ultimate fracture. This clearance should not be less than 1-64 of an inch. The pinion should then be wiped clean and placed in boiling water until thoroughly heated through. This will take from three quarters of an hour to an hour, depending on the size of the pinion. When hot the pinion should be immediately placed on the shaft and rammed home on its seat. The nut should be tightened up while the pinion is still hot, care being taken to see that the lock washer is properly seated to hold the nut. The pinion should then be rammed a second time and the nut again tightened. The whole operation should be performed as quickly as possible before the pinion has had time to heat up the shaft.

For driving on the pinion a block of wood, approximately the diameter of the pinion, and about 3 or 4 ft. long, is recommended; the end being cupped to clear the thread on the armature shaft. The use of a heavy sledge hammer, even when used with a protecting ring of soft metal, sets up severe stresses in the pinion and should be avoided. Pinions should never be heated by a gas flame, on account of the danger of unequal heating and of injuring the heat treatment.

When removing pinions, the common practice of driving wedges between the bearing housing and the pinion not only causes shocks, which are likely, particularly with case hardened pinions, to develop fractures, but is also liable to damage the end of the armature linings of frame head and spring the armature shaft. Pinion pullers that grip only two or three teeth are only slightly less injurious, and only those which grip all the teeth should be used.

With some designs of motors the projection of the bearing housing may require chamfering off to give sufficient clearance for the pinion puller, but it will be found more economical to do this than to injure the pinion.

With split gears the bore of hub and the diameter of the axle seat are the same. The gears are bored to size with shims about 14 mils in thickness between the halves placed close up to the bore; the gear being pulled together at its outer circumference. These shims should be removed before fitting the gear to the axle.

With solid gears the bore of the gear and the diameter of the axle at the gear seat should be carefully checked for the correct press allowance. This press allowance varies with the construction and treatment of the gear, and is from 1 to 1½ mils. per inch of diameter of the gear seat. The pressure required to mount the gear depends somewhat on the length diameter of the hub, and on the condition of the two surfaces. Before pressing on the gear the bore should be carefully cleaned, and the seat on the axle should be white leaded to prevent abrasion of the surfaces. The gear can then be pressed on and does not require any heating before so doing.

With composite gears, i.e., gears having cast steel centres and forged rims, where these are assembled by the customer, care must be taken not to overheat the rim when shrinking it on. The rim should be heated by a gas ring of such a diameter that when placed in the centre of the rim the flame just touches the bore. A sheet of iron placed on top will help to retain the heat. The correct temperature may be judged with sufficient accuracy by dropping water on the rim. When the water snaps, the required temperature has been reached, and the rim can be slipped into place. The temperature of the rims should not be allowed to exceed 500°F., and under no circumstances should the rim be heated in an oven, or the flame of the gas heater allowed to touch the tooth. After the motor has been mounted the truck should be moved back and forth before the gear case is put on, to ascertain that the gear operates freely.

It is not right for one railway company to assume the life values established on some other road, as the life is to a large extent affected by the gear ratio. However, decided variations are found in the life of the same grade of gears and pinions on two roads with duplicate equipments. The greatest factor in explaining this is the grit or cutting substance, which accumulates in the gear case, and which mixed with the lubricant acts as an abrasive on the gear and pinion teeth. It is surprising the percentage of grit that has been found in numerous cases investigated. This has been found in extreme cases to be over 20%. The sand usually enters between the gear hub and gear pan in the form of street dust, brake shoe dust and wheel wash. Carelessness when adding lubricant, or when the lower half of the gear case is lying in the pit during inspection, is another way in which dirt gets into the lubricant.

Another factor accounting for two different roads, with duplicate equipments and the same grade of gearing getting different life values, is in allowing excessive wear of the armature and axle linings.

It has been found good practice to set the maximum allowable wear of armature linings at 1-16 in. and of axle linings at ⅛ in. Still another factor is the kind of lubricant used. Experience in general has shown that the lubricant should be soft enough to level back and be again picked up by the gear teeth.

Pinions are sent out coated with rust resisting compound. This is liable to pick up sand and grit during transit and should be carefully removed before the pinion is put in service. The gear case should then be assembled and the lubricant put on the teeth, and sufficient in the bottom of the case to insure the teeth of the gear dipping into it.

Gears should be inspected sufficiently often to insure shortage of lubricant being detected, and a fresh supply of grease being added if required. The gear and pinion should never be allowed to run dry. Should this, however, occur, the whole case should be cleaned out before putting in new lubricant.

From actual service observations it is found that the best results are obtained by operating gears and pinions of the same hardness together. In so doing the gear will outwear two and sometimes three pinions. The second and third pinions must mesh against worn gear teeth, and having to adjust themselves to the proper contour will have a much shorter life than the first pinion. An equal pinion and gear life can be obtained by working a hard pinion with a soft gear; but this is not a profitable combination, as the gear is much the more expensive of the two, and a high pinion life may be obtained at the expense of the gear life.

The best results with modern high grade gearing are obtained with the solid gears; and their use as against split gears is strongly advised wherever possible. Split gears of the case hardened or armorized type can be had, but they are in every case more expensive than a solid gear of the same type, due largely to the loss through warpage in treatment of the cast steel halves. It will amply repay any operator to look thoroughly into the question of substituting solid high grade gears for split gears. A high grade type of gear, while costing from 1¾ to 2¼ times as much as a cast steel gear, will give at least from 3 to 4 times the life, in addition to which the saving of labor in changing the cheaper gears at each replacement must be considered.

With regard to the consideration of gear ratio, the selection of the right railway motors for a particular application requires accurate knowledge of service conditions on the part of the manufacturer, in order that the railway may obtain the most economical equipment from the standpoints of first cost, power consumption and maintenance cost. In frequent stop service so large a portion of the running time is taken up in accelerating and braking [illegible] the actual duration of stops, that a difference in gear ratio only very slightly affects the schedule speed, and the schedule which can be obtained is practically determined by the number and duration of stops in the service. The motor losses and the energy consumption are a minimum with the maximum gear reduction that can be used to make the desired schedule.

The speed at which a car having a given driving wheel diameter will be moved by given motors at a given current and voltage depends upon the gear ratio. If the gear ratio be increased the speed of the car at a given current will be reduced, the tractive effort at the wheel treads will be increased, and the possible rate of acceleration will consequently be increased. If, on the other hand, the gear ratio be reduced, the speed of the car at a given current will be increased, the tractive effort at the wheel treads will be reduced and the possible rate of acceleration will consequently be decreased. Thus, with a low gear ratio, greater current will be required to produce a given tractive effort and acceleration than would be required with a higher gear ratio. As a case in point, an increase in the gear ratio on cars in city service gave a saving of 10% in energy consumption, allowed an increase of 30% in stops, while only reducing the schedule speed by 2%.

In city service there is little opportunity for a car to get up to its maximum free running speed, and there may be little opportunity for coasting, whereas high rates of acceleration and braking are necessary. To obtain a relatively small percentage increase in schedule speed for city service larger motors may be required, and the energy consumption will be greatly increased.

Schedule Speed in City Service.

Duration of stops 10 seconds.
Straight level tracks.

Stops per mile	Schedule speed in miles per hour. Schedule 1.	Schedule speed in miles per hour. Schedule 2.
6	10.00	11.60
7	9.30	10.40
8	8.75	9.75
9	8.00	8.90
10	7.60	8.40

In the above table schedule 1 gives the schedule speed in miles per hour which can be obtained with a reasonable or normal consumption of energy. Schedule 2 gives corresponding schedule speeds which can only be obtained with a considerable increase in the size of equipment and a large increase in the energy consumption. Taking the case of 7 stops per mile, the speed in schedule 2 represents only 12% increase over the speed in schedule 1, whereas it requires over 50% more energy to secure this slight increase in speed.

DISPENSING WITH JURIES IN DAMAGE ACTIONS AGAINST RAILWAYS.

By F. B. Griffith, Superintendent, Interurban Railway Division and Claims Agent, Dominion Power & Transmission Co., Ltd.

This article is written at the request of the Honorary Secretary-Treasurer of the Canadian Electric Railway Association, and is the result of a communication received by him from Mr. C. B. King, Manager of the London St. Ry., commenting on the damage actions brought against that company during 1915. In almost every case the great preponderance of evidence was in favor of the company; yet in every case the jury brought in a verdict for the plaintiff. Mr. King mentioned these instances as examples of the attitude that juries throughout the country take toward public utility corporations, and, for that matter, always have taken. He points out that this bias is becoming greater as time goes on, and suggests that such injustice will soon become a serious matter for our industry, if it has not already become so. He asked that the question be brought before all member companies, with the idea of obtaining the views of each, together with any suggestions as to some concerted action for relief that this Association might take.

Member companies were accordingly advised, and our Secretary also brought the matter to the attention of the representatives of the Grand Trunk, Canadian Pacific and Canadian Northern Railways; 17 replies were received; 14 from member companies and 3 from the principal steam railways just mentioned. A perusal of the replies indicates the following:

1. All companies are agreed as to the injustice suffered by public utility corporations in damage actions tried by juries.
2. All would prefer to have such actions administered by a judge without a jury.
3. Some would prefer to have actions disposed of by the Dominion or Provincial railway commissions, according to the charter of the company, instead of by the Provincial law courts.
4. The matter involves legislation in the several provinces, as well as possible Dominion legislation.
5. The co-operation of the principal steam railways can be confidently relied on.

6. All agree that relieving measures would be difficult to obtain.

The following are among the suggestions and comments specially noted in the replies:—

(a) To endeavor, with the co-operation of the steam railways, to induce the different Provincial legislatures to pass bills affecting railways somewhat similar to that existing in Ontario, governing damage actions brought against municipalities.

(b) To endeavor to have such actions administered by the Dominion Railway Commission or Provincial railway boards, according to company charters.

(c) To endeavor to induce Provincial legislatures to pass bills giving courts of appeal more power to alter findings of juries on questions of fact and on questions of assessment.

In commenting on this matter I will not deal with the advisability of getting such legislation put through, as practically all are agreed that any of the three alternatives just mentioned would be preferable to the present state of affairs. Objections to any such measures would surely be raised and would emanate from various sources, chief among which would be the members of our legal profession, both those in Parliament and those who are practicing law, as such measures would surely affect the clienteles of a number of lawyers throughout the country, and no one knows it better than they. I may also mention that a bill presented to the Manitoba Legislature by the municipalities of that Province, asking for similar legislation as exists in Ontario with regard to damage actions against municipalities, was thrown out recently.

On the other hand, numerous sponsors to the merits of our contentions could be found, although we could hardly expect that all would express their views formally. Other public utility industries, besides our own, representatives of the larger private industries, holders of public utility securities, the financial institutions and all fair minded persons who have watched court procedure at all, could be relied on for moral, if not actual support. The judiciary itself, I think, would agree as to the injustice of the jury system as applied to ourselves, although they could hardly be expected to endorse such views publicly. It is from these classes that we could surely expect support and co-operation. In all likelihood other public utility industries, and perhaps private industries, would like to be included in such legislation, and it would require careful strategy on the part of any promoters of such a scheme, in soliciting assistance, to decide what other industries, if any, it would be best to include with our own and what industries should be left out. The bigger the representation making the appeal, the greater the chances of success, providing, of course, that the introduction of other industries than our own would not introduce complications that would hinder rather than help.

As to the advisability of having these matters administered by the railway boards instead of by judges of provincial law courts, I would not undertake to recommend a choice; preferring to let a decision be made by this Association. The railway boards should be in a better position to determine the merits of railway cases than ordinary judges, as they are better equipped to determine the merits of railway arguments. Moreover, as pointed out in one of the letters perused on this subject, they at present handle practically all questions of contention arising between the railways of the country and the public, except damage actions.

As to the question of solving the problem by endeavoring to have

courts of appeal given more jurisdiction over the findings of juries, I would point out that the solicitors of the Montreal Tramways Co. are endeavoring to effect this in the Quebec Legislature at the present time. A law giving proper scope in this connection would go a long way to improve conditions and would, I think, be the next best measure to having the jury dispensed with.

In conclusion, I take the liberty of recommending that a committee be appointed by this Association, with power to add to its numbers from either inside or outside the Association, to investigate this question in all its various phases and to report after so doing. In my opinion, the matter is one well worth any reasonable trouble to which this Association might go in investigating its merits.

A claims agent informed me recently that on account of the present jury system, railways paid out at least double the amount for damage claims that a proper application of justice would demand. I am inclined to agree with him; moreover, conditions are not improving. Indications are that they are becoming worse, and, to use the expression contained in one of the replies to our Secretary on this subject, I think that some action should be taken, even if immediate success is not in sight.

PROBLEMS CONFRONTING ELECTRIC RAILWAY OFFICIALS.

By F. S. Livingston, Traffic Manager, Toronto and York Radial Railway Co.

It has been suggested by the Assistant Manager of the company I represent that a suitable topic for discussion at this meeting of the Association would be "How best can some of the problems of the electric railway business be solved?" It is reasonable, I think, to assume that all electric railways have problems. Some, perhaps, have few, and others not a few. My company has many. But I will not attempt to submit them just now, for if I did some of you might feel like rising to a point of order and telling me that you have troubles of your own and to go and tell mine to a policeman. I would like, however, to submit for your usual careful consideration a few of the problems from which the electric railway business is not immune. I trust my few poor remarks will at least precipitate a discussion. Not to precipitate, as Noah Webster, LL.D., defines the word, "To hurry on thoughtlessly," or "To throw to the bottom of a vessel," but rather as a basis on which to feed up the controller of discussion.

One of the important problems of the electric railway business is the increase in operating expenses. It is not my intention to review the various forms of expenditures and the large original costs the change from horse cars to the modern trolley gave rise to. Suffice it to say that the electric railway business is today providing more service, improved service, and a very much more costly service, for the same old fare that father used to pay.

Extensions of service have been made where little traffic exists. These are largely due to real estate agencies opening up subdivisions in close proximity to the railway. There are instances where they have assured their clients that the railway company has indicated its desire to extend its lines to the property, or if the railway has already been extended, assurance is given that special service and stops will be arranged. A few years ago one of the leading real estate agents in Toronto opened up a property on one of the divisions of the Toronto

and York Radial Ry. A friend (a rich one evidently) wished to invest, as he remarked, "some of his money," in the property referred to, and before closing the deal, desired to know if the company intended giving reduced rates and frequent service to the property. Being somewhat inquisitive, naturally I am so, I made it a point to do a little investigating, whereon, dropping into the headquarters of the real estate company a few days later, I was attended to by a very courteous sales manager. Intimating my desire to obtain information pertaining to the particular property in which my friend was interested, I was shown the various plans, quoted various prices, and then, to my surprise, informed of what the railway company in a very few weeks was going to do. It was rather a peculiar, and I might say a pleasant sensation, to hear what he had to say. Upon informing the gentleman that I would consider the proposition, he requested my name and business address. My business card was my response as I made a somewhat hasty retreat to the exit. It is reasonable to assume that the sales department thereafter referred to the Toronto and York Radial with compunction. By the way, it might pay the electric railways to go into the subdivision business themselves.

Within the last few years a great variety of conditions have been imposed upon electric railways by legislative, civic, and other bodies, in attempts to adjust features of electric railway service which have been made the subject of complaints. And there are many instances I am sure where the electric railway has adjusted features of service without compulsion from any source. These and other circumstances all tend towards the high cost of operation. It would be interesting, I am sure, if the members present could explain how the expenses and burdens of the electric railway business could be so lightened that they may continue to furnish service for the existing rates of fare and still earn a reasonable return upon the capital invested.

Another, and very important question, I think, is the problem of regulating the selling price of the electric railway product. There is really only one product the electric railway business has for sale. It is service. And what a demand there is for it! Just as the children cry for that well known patent medicine, the public cries for service. But whether the demand be great or small, the selling price for electric railway service apparently cannot be raised. And why should this condition exist? The electric railway business is a retail business. It is like any retail business in that it is dependent entirely upon a local market for the sale of its product. If its product is good (nowadays it must be good) it cannot raise the selling price. Any other retail business, if its product is good, raises its selling price in accordance with the demand and quality of product. If the business is not remunerative, the retailer removes his business to a more favorable location. What opportunity has the electric railway business of pulling out and removing to a more favorable location? The expensive plant, necessary for its operation, alone makes removing prohibitive.

The electric railway business is in at least one other respect very much like the retail business. Both have their bargain days. I would wager that the electric railway business has a wide margin on the retail business in so far as bargain days are concerned. Every day is bargain day with the railways giving commuters' rates. In many respects the railway companies are alone responsible for the introduction of reduced rates for commuters. Others have, so to speak, had their rates "wished on them" by the early day officials, who granted almost any concession demanded by the municipalities through which they

desired to build the line. One cannot help feeling that the men who were courageous enough to have invested their wealth in the early development of electric transportation, were deceived into the belief that the cost of producing service by the use of electricity would be so reduced that all that was necessary to do was to sit down and see the money flow into the coffers of the company.

Can it be that we are being deceived into the belief that the electric railway business can go on and on improving equipment, improving the plant necessary for its operation, improving everything pertaining to service and continue to sell the product for, if I may be permitted to repeat, "the same old price that father used to pay"? This problem might be approached from the viewpoint of, "Should and can the unit of fare be increased?"

The problems involved in the public relations of the electric railway business are quite as important, and in many respects much more complicated than the problems of operation. No one knows better than the officials of an electric railway, the power of public opinion, or the importance of securing and holding the good-will of the public. The travelling public, as a rule, have very little knowledge as to what constitutes reasonable service. Very few, if any, have a conception as to what it costs to provide a reasonable service.

Just here let me relate another little incident. Coming into town a few days ago, in talking with one of our patrons, he enquired of me, "What would a car like the one we are riding on cost?" I told him, and the expression of amazement on his face was pleasing to behold. "Why," he almost whispered, "What a 'helluvalot' of nickel fares you would have to collect to even pay the cost of depreciation, let alone pay for the car. This is really typical of the average passenger when he pays his fare on the cars. He little knows that the money paid has to provide for a great many other things in addition to his ride.

The service furnished by many, if not all the electric railways in Canada should merit a larger measure of public co-operation than is accorded. The reason the public so often fails to give credit where credit is due is not because the public on the whole is unfair, but because it is misinformed, or not informed of the plans and policy of the company. The public is today being educated to the belief that it has the right to know practically everything pertaining to the railways' affairs. If you refuse to answer their questions, or in answering them do so evasively, the public would be convinced that you were afraid to have the facts known. Speaking of wrong information, I am reminded of a story. A policeman was passing along the street just as a man jumped out of a third story window. The officer immediately placed him under arrest and led him to the station house. On their arrival the magistrate asked the officer what his prisoner was charged with. The officer replied, "Attempted suicide from a third story window." The prisoner interrupted the officer and said that he did not attempt to commit suicide. The magistrate, somewhat surprised, asked, "What does a man jump out of a third story window for?" The reply from the poor fellow was, "I did it because a woman lied to me." "A woman lied to you?" repeated the magistrate. "What do you mean?" "Well," responded the victim, "she told me her husband was in Chicago, and he wasn't."

If the company disregards the public it can hardly expect fair treatment. On the other hand, if the public believes the company is trying to give an efficient service, its efforts will receive some recogni-

tion and, where some conditions are unavoidable, they will be accepted with reasonable good nature by a large portion of the community.

There are other problems that may be more or less important than those I have submitted, but I will be amply repaid for my effort, if from the discussion (if any takes place) something would result to materially reduce the cost of operation, or failing this, materially increase the selling price of electric railway service, at the same time establishing a better understanding between the company and the public.